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ABSTRACT

Designed for educational planners and decision makers, this report reviews the principles and methods of demography. The first section discusses demographic rates and measures, including a basic demographic equation, crude rates, cohort measures, parity progression ratio, and life tables. The next three sections examine three demographic factors relating to educational planning. They are as follow: mortality; fertility (United States fertility in historical perspective, birth expectations, and differentials); and migration (biological and social characteristics of migrants, geographic patterns in migration, and urbanization and metropolization). The final section discusses general methods of population projections: extrapolation, ratio method, cohort-component method, and modeling. (Two related documents are available in ERIC: The Use of Mathematical Models of Student Flow in Educational Planning [CE 019 498] and State and Local Responsibilities for Planning Occupational Education [ED 133 479].) (JH)

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DEMOGRAPHY AND EDUCATIONAL PLANNING: A REVIEW AND SYNTHESIS

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INTRODUCTION

Increased emphasis on comprehensive planning at all levels requires that educational decision-makers develop greater capabilities in the acquisition and use of demographic information. Historically, concern for demographic information frequently amounted to little more than relatively short-range projections of public school enrollments used for fiscal planning and long-range population projections for facilities planning. However, recent population changes pose a significant challenge for educational policy-makers. The transition from a three-child to a two-child average family can be expected to result in more women entering the labor force, many of whom will require remedial or refresher training. A declining birth rate has already led to diminished enrollments in elementary schools and will soon result in a reduced number of teenagers entering the labor force. A larger proportion of older persons will create a greater demand for training for career advancement rather than for initial job entry. Although declining, the birth rates for minority group populations remain 40 to 50 percent greater than for whites, resulting in an expectation of a greater proportion of minority persons in the young adult group seeking entry to the job market.

These trends make it imperative that planners consider the impact of demographic factors in the formulation of educational policy. Yet, although educational planners are becoming increasingly knowledgeable in many areas of planning, they remain largely uninformed with respect to demographic principles, methods, and procedures. Limited knowledge has hampered their ability to evaluate demographic information and has resulted in their acceptance of demographic projections largely as a matter of faith.

The present report is, therefore, directed to those planners and decision-makers in education who feel a need to become more sophisticated in their understanding of the principles, methods and materials of demography. It is not a cookbook which attempts to train demographers but, rather, a review of recent materials in demography and synthesis of this material into a form that, hopefully, is addressed to the needs of those involved in educational planning. The report is not oriented to the solution of demographic problems nor to the computation of demographic rates or projections. There are many handbooks available which can do this far better, and a number of these appear in the bibliography. It is hoped, however, that a review and synthesis of demographic methodology will enhance the ability of the educational planner to make a more informed evaluation of demographic data. Demography, as a tool in educational planning, is useful to the extent of the skill of those making the ultimate decisions to use it effectively. If poor projections are accepted, it should not be because of a lack of ability to evaluate them effectively.

The following chapters present a brief introduction to the field of demography together with a discussion of some of the rates and measurements used, followed by separate discussions of mortality, fertility, and migration. The paper concludes with a brief look at population projections and some of the methods used in making such projections.

DEMOGRAPHIC RATES AND MEASURES: A REVIEW

There are but two basic processes by which all population change occurs--people enter and people leave. The difference between population entrants and withdrawals over successive time periods produces the net change in population size and determines its rate of growth. There are two processes by which new members either enter or leave a population: through birth or immigration, and through death or emigration. For certain territorial units, such as the world or contemporary China, the sources of entrants and withdrawals are birth and death. For sub-national units, migration and out-migration replace immigration and emigration as sources of change in addition to birth and death. These relationships are frequently expressed by the basic demographic equation

$$P_t - P_o = B - D + I - O \qquad (1)$$

where P_o is the population at the start of the period and P_t is the population at the end of the period. B and D are the births and deaths that occur over the preiod, while I and O refer to in- and out-migration. It is generally the case that the territorial unit is well-defined, as is the time period from o to t. This basic equation or, as it is sometimes called, the "balancing equation" or "component equation" provides a means of assessing the change over time, the rate of change, and the relative contribution of each separate source of change. The individual factors--birth, death and migration--are called demographic components or simply components. As can be seen, there could be an infinite combination of values for each of the individual components which could produce any given amount of change in the population. As long as the value of all but one component is known, or is capable of estimation, the other component can be determined.

Through solving for P_t, where t refers to the present, the balancing equation provides the basis to make a population esimate:

$$P_t = P_o + B - D + I - O. \qquad (2)$$

If P_t in equation (2) has reference to some future point in time and if one assumes what the values of B, D, I, and O will be over the period from o to t, then equation (2) yields a population projection.

One additional example of the basic demographic equation follows. Assume one were interested in what the net effect of territorial movement was for a given period. Typically, movement from one territorial unit to another is not recorded (at least at the sub-national level), but births and deaths are known from vital statistics. Therefore, an estimate of the change due to migration (M) where M = I - O can be obtained as

$$M = (I - O) = P_t - P_o - (B - D). \qquad (3)$$

Although movement from one population to another over time is referred to as migration, much of demographic analysis is concerned with other forms of movement. Without any loss in generality, the component of territorial movement can also be used to express any change of status in a population. In fact, it is this extension of the analysis of a change in territory to one of status which can be employed to differentiate social from formal demography. Much of demographic analysis is concerned with this type of movement. For example, the population of married people is constantly being modified by the death of some of its members, by new marriages and by divorce. The process of social stratification represents another analogous situation where there are entrants and withdrawals from one social level to another. In the educational system there are entrants in the form of new enrollments from births or movement from one school to another and withdrawals through death, dropping out, or changes in schools. The transitions from student to worker and from worker to retiree are but different aspects of this basic change.

The basic demographic equation, however, while serving well to illustrate the interrelationships between components of change, is not satisfactory for analytical purposes, for few populations can be adequately described by it. Populations are not homogeneous; they differ not only from one another but over time. These differences are of two general types. The first is related to the differences in the distribution of persons by their age and sex, which are referred to by demographers as structural or demographic characteristics. Some populations have a larger number of younger or older persons than others, and there are frequent differences between the numbers of males and females--either in the total population or at certain ages. The second type of differences is usually referred to as social characteristics and includes a multitude of criteria such as race, marital status, educational attainment, occupation, income, industrial activity, religion, type of family unit, and so on.

Several aspects of this heterogeneity of population are helpful in understanding the dynamics of a particular population. The first aspect is that a population at any point in time is a composite of events which have taken place previously. For example, the number of births today reflects a mixture of past and contemporary events, such as levels of fertility a generation ago, mortality conditions prevailing during the intervening period which have partially determined the number of young women presently in their productive years, the number of marriages which took place within the past few years, and contemporary social and economic conditions which affect the timing of births relative to marriage.

Another dimension of the dynamics of a population is the extent to which different segments of the population are involved or participate

differentially in various forms of social or demographic activities. The entire population, for example, does not participate equally in the labor force, just as only a limited segment attends school. Only women within a restricted age range bear children and then, typically, only if they are married.

Mortality provides a useful example of how cross-cutting factors combine to produce differentials. While all persons are mortal, some are more so than others. The likelihood of death is not uniform but displays systematic variation by age. The newborn infant is more likely to die then than at all subsequent periods of his life until somewhere around age 60. Females typically outlive males, and in most areas of the United States whites outlive blacks. Yet white males, on the average, are less likely to survive any given period of time than black females.

In order to understand the processes of change in a population, one must understand their sources--not only in the likelihood of events occurring but also in the nature of compositional variation. It is for this reason that one of the major strategies in demographic analysis is the decomposition of total population into various subgroups. More often than not, the limiting factor in the extent to which a total population is decomposed is the availability of data by detailed characteristics. By decomposing a population into specific categories, the relative importance of each specific category can be assessed in relation to either the total or some other category.

The basic balancing equation (2) can be made specific for a particular subgroup such as males, retired persons, women of childbearing age, or a school population. By the addition of a superscript to reflect the restriction to a particular subgroup, the basic demographic equation would be written as

$$P_t^i - P_o^i = B^i - D^i + I^i - O^i \qquad (4)$$

where the superscript i denotes membership in a particular subgroup.

So far the discussion has been in terms of the numbers of events or people. While numbers represent one tool for assessing change--a very important and versatile one--the use of absolute numerical values is not by itself sufficient, since it is difficult to compare absolute numbers between two populations either longitudinally or cross-sectionally. A comparison of the number of deaths, births, or high school graduates between New York and North Carolina taps only a single aspect--absolute differences. Demography, like many fields, uses a large number of measures to express the relative size of one subgroup or occurrence of one event to another. The most common are rates and ratios.

The most basic rates are the so-called "crude" rates which are obtained by dividing the number of events which took place over a period

of time by the population exposed to that event. The population exposed to an event, as we will see, is usually only approximated and sometimes then with considerable difficulty. The population which forms the denominator may be the population at the start of a period, the end, an average of the two (usually taken as the population at the middle of the period), or some other, more complex definition. The period for most crude rates is one year. The crude death rate is obtained by

$$CDR = \frac{D}{P} \times k \qquad (5)$$

where D is the number of deaths, P is the population at the middle of the period and k is a constant, usually 100 or 1000.

Crude rates have the advantage of being simple to calculate, and the difference between crude birth and death rates reveals the extent to which a population has increased or decreased as a result of biological processes. This difference is called the Rate of Natural Increase.

However, most crude rates are just that; in fact they usually are not rates at all in the technical sense of the term (Barclay, 1958, pp. 16, 55), for the population of the denominator does not usually reflect exposure to the risk of the event recorded in the numerator. Thus, a crude birth rate relates births to the total mid-year population, but only a segment of this population is exposed to the risk of childbirth. In a similar vein, an application of this method for assessing educational enrollment, the Crude Enrollment Rate, reflects the relation between the number of persons enrolled in school (usually K - 12) to a mid-year population. However, it is obvious that the total population is not exposed to the "risk" of school enrollment. Those below a certain age, those who have graduated and those who have not graduated who are over a certain age are either not exposed or only minimally exposed.

Even where exposure is universal for the population, the amount of risk is not the same for all segments. Thus, the crude death rate, while it relates deaths to a population of persons alive, all of whom are exposed to death, presents a distorted picture, since there are significant mortality differentials by age, sex, socioeconomic status and genetic factors. To the extent that there are differences in the composition of populations, the resulting crude rates will reflect these differences.

To illustrate, the crude death rate is (or should be) a measure of the extent to which there are differences in mortality between two populations. For 1960 the crude death rate for North Carolina was 8.2 per 1000 population, and in the same year the CDR for Massachusetts was 10.2, which could be interpreted as indicating that mortality was lower in North Carolina than in Massachusetts. Such was not the case, however, for the likelihood of death was higher for all North Carolinians at all ages until age 65+, at which point Massachusetts had

slightly higher rates. What these crude rates do reflect is not so much the difference in mortality between North Carolina and Massachusetts as a difference in the age structure of the two populations. North Carolina had experienced a much higher level of fertility prior to 1960 and, as a result, had a much larger portion of its population concentrated in the younger ages. Because of the lower mortality at younger ages, the preponderance of younger persons in North Carolina more than off-set its higher mortality.

The strategy employed to surmount this difficulty is to restrict the events to the population at risk. Thus, fertility could be measured as the relation between births and the female population of child-bearing age:

$$\frac{B}{\sum_{a=15}^{45} P_a^f} \cdot 1000. \qquad (6)$$

where P_a^f is the population of females of age a and B is the number of births. Likewise, for purposes of educational planning, the crude enrollment rate could be made more specific by restricting the denominator to the population between the ages of 5 and 34, giving

$$\frac{E}{\sum_{a=5}^{34} P_a} \cdot 100 \qquad (7)$$

where E is the number enrolled and $\sum_{a=5}^{34} P_a$ is the sum of the population from age 5 to 34. The rate in (7) is frequently called a general enrollment rate.

Both examples in (6) and (7) represent an improvement in expressing the relationship between an event and the population exposed to that event. Another strategy used to refine the relationship is to restrict the age range in the numerator and denominator. Since most demographic and social phenomena display variation by age, many age-specific rates are employed. Examples include an age-specific death rate

$$\frac{D_x}{P_x} \cdot 1000 \qquad (8)$$

where the subscript refers to persons of a specific age. Typically, age-specific rates are not calculated for single years but for a number of years, usually 5 or 10 years. Thus, one would find an age-specific birth rate for women aged 20 to 24

$$\frac{B}{P^{f}_{20-24}} \cdot 1000. \qquad (9)$$

An age-specific example from the field of education would be enrollment rate:

$$\frac{E_x}{P_x} \cdot 100 \qquad (10)$$

where E is the number of students enrolled at age x and P_x is the population of the same age.

Not all specific rates match events to the population at risk. Consider a grade-specific enrollment rate, for example:

$$\frac{E_g}{P_x} \cdot 100 \qquad (11)$$

where E_g refers to persons enrolled at grade g and P_x refers to the age of the population corresponding to a particular grade. Although there is a general correspondence between age and grade, it is far from perfect, since there will be students younger or older than their corresponding grade would indicate. An obvious refinement of (11) would be an age-grade-specific enrollment rate expressed as

$$\frac{E_{xg}}{P_x} \cdot 100 \qquad (12)$$

where E_{xg} represents the enrollment at age x and grade g. To the extent that there is a closer correspondence between the numerator and denominator of (12), this represents an improved measure.

Specific rates are frequently restricted in demographic analysis to other relevant population compositional categories such as sex, race, rural-urban background, and so forth. One drawback to the use of specific rates is that the number of separate rates increases with the number of categories used to characterize the population. In comparing two populations at two different points in time by race and sex for each of five age categories, there are 40 possible separate rates (with race dichotomized). While such detailed analysis is often needed, many times a smaller number of summary rates can provide a better picture of change or differences. The summary value illustrated in Equation (13) is a standardized rate which indicates what an expected rate would be, given the compositional differences between two sub-populations. The standardized rates are crude rates which have been "adjusted" for compositional differences. Since a crude rate can be expressed as a weighted sum of the specific rates, where the weights are the proportion of a population in a compositional category, the crude rate can be expressed as

$$\frac{E}{P} = \frac{\sum_a p_a - M_a}{\sum_a p_a} \qquad (13)$$

where e_a is the number of events occurring to the a^{th} compositional category of the population, p_a is the size of the a^{th} category, and $M_a = e_a/p_a$ is the specific rate for the a^{th} category of the population. If e_a' and p_a' represent a second population, then the difference between the two crude rates is

$$\frac{E}{P} - \frac{E'}{P'} = \frac{\sum p_a M_a}{\sum p_a} - \frac{\sum p_a' M_a'}{\sum p_a'} \qquad (14)$$

$$= \sum_a \frac{p_a}{\sum p_a} (M_a - M_a') + \sum_a M_a' \left(\frac{p_a}{\sum p_a} - \frac{p_a'}{\sum p_a'}\right)$$

which contains two separate components of difference: a component due to rate differences and one due to compositional differences. When the rates of a given population are applied to the composition of another population (usually called the standard population), the expected standardized rate is

$$\frac{\sum_a p_a^s M_a}{\sum_s \sum_a p_a^s}, \qquad (15)$$

where p_a is the size of a compositional category of the standard population and M_a is the specific rate for the a^{th} category of the given population. The component due to a rate difference is

$$\frac{\sum_a p_a^s M_a^s}{\sum_a p_a^s} - \frac{\sum p_a^s M_a}{\sum_a p_a} = \frac{\sum p_a^s}{\sum_a p_a^s} (M_a^s - M_a) \qquad (16)$$

while the difference in the two rates which is due to composition is

$$\frac{\sum p_a^s M_a}{\sum_a p_a^s} - \frac{\sum p_a M_a}{\sum p_a} = \sum_a M_a \left(\frac{p_a^s}{\sum_a p_a^s} - \frac{p_a}{\sum_a p_a}\right) \qquad (17)$$

A numerical example will clarify the application of standardized rates. A recent Current Population Reports publication (U. S. Bureau of the Census, 1972b, Table 1) shows that the crude enrollment rate for the United States in 1971 was 55.8 for the white population and 58.8 for nonwhites. Thus, from (14) the difference was 55.8 - 58.8, or -3.0 fewer per 1000 population aged 3-34 enrolled for whites than nonwhites. If the white population is taken as the standard population from (15),

the expected nonwhite enrollment rate is found to be 54.8. In other words, if the nonwhite population had the same age structure as the white population with their current age-specific enrollment rates, they would have a lower crude enrollment of about 1.0 per thousand population than whites (54.8 - 55.8). The total difference between these two rates has two components: a rate difference of -1.0 per 1000 and a composition difference of 4.0 per 1000. In other words, the unstandardized comparison of the two crude rates would indicate that nonwhites had a higher enrollment rate than whites, but the standardized rate indicates that most of this difference is due to a much more favorable age structure of the nonwhite population reflected by a larger proportion of its population in the years where enrollment rates are highest, e.g., between ages 6 and 16. A full treatment of standardization can be found in several standard demographic methodology texts (Barclay, 1958, pp. 161-166; Spiegleman, 1968, pp. 102, 115; Shryock and Siegel, 1971, pp. 418-25).

The above examples are illustrative of the strategy to achieve a closer correspondence between events and the population exposed. The examples represent one large class of measures--period measures. There is another class of measures which have considerable importance for both demography and educational analysis. These are cohort measures. Cohort measures are distinguished from period measures in that with the former, a group of persons having some common origin are traced longitudinally over time. Period measures reflect a cross-section at one point in time. There are many criteria which can be used to delineate a cohort--birth, marriage, school enrollment, and graduation being but a few. Educational personnel are probably more familiar with the cohort approach than are most non-demographers. The progression of students through the educational system from grade to grade and level to level is a natural application of the cohort concept. An extension of the period measures expressed earlier in a cohort form would be the analysis of educational progression. One such measure is the grade retention rate

$$\frac{E_{a+x}^{y+x}}{E_a^y} \qquad (18)$$

where E_{a+x}^{y+x} represents the entrants to grade a + x in year y + x and E_a^y represents the enrollment in grade a for year y. This measure reflects the progression over time of one grade cohort, for example the proportion of eighth-grade students in 1972 who progressed to the ninth grade in 1973. This measure, however, is afflicted by several sources of error, including drop-outs, deaths, repeaters, transfers, and skippers. A refinement of the grade transition rate is based on the proportion of graduates from one level who progress to the next grade or level. Such a measure is the grade transition rate and is expressed as

$$\frac{E_{a+x}^{y+x-1}}{G_a^y} \qquad (19)$$

where G_a^y represents the graduates of grade a in year y and E_{a+x}^{y+x-1} the entrants to grade a + x in year y + x - 1.

A measure which is quite similar to the grade transition rate in (19) is the parity progression ratio which is employed in demographic analyses of fertility. This measure reflects the conditional probability of women who have had a birth of a given order (or parity) having a birth of a higher order. The parity progression ratio is expressed as

$$\frac{B^{n+1}}{B^n} \qquad (20)$$

which yields the proportion of women with an nth-order birth who progress to the next parity.

The grade transition rate and the parity progression ratio both reflect a form of cohort measurement. However, it is more typical for cohort analysis to deal with the complete history of a group of people as they progress over a longer time span rather than the limited span of time reflected by progressing from one grade to the next or from one parity to the next. A more typical approach would be to follow all first-grade entrants through their entire educational career or a cohort of women married at a particular time and followed through their reproductive years. Since data do not routinely exist to study fertility of marriage cohorts for the United States, the cohort base is usually the year of birth. Thus, the complete cohort fertility for the most recent birth cohort who have reached the termination of their reproductive lives by age 45 would be the women born in 1930. Since it is usually assumed that the reproductive period for analytical purposes is from age 15 to age 45, the total number of children born to this cohort would be

$$b_{15}^{1945} + b_{16}^{1946} + b_{17}^{1947} + \ldots + b_{45}^{1975}$$

where b_{15}^{1945}, for example, is the number of children born to 15 year old females in 1945. In practice, however, five-year age categories are used rather than single years of age, as in

$$b_{15\text{-}19}^{1945\text{-}49} + b_{20\text{-}24}^{1950\text{-}54} + b_{25\text{-}29}^{1955\text{-}59} + \ldots + b_{40\text{-}44}^{1971\text{-}75}. \qquad (21)$$

The advantage of cohort measures as in (21) is that they present a dynamic picture of the process of fertility. Since fertility has a range of temporal variation, it is possible to compare different cohorts at similar periods of their reproductive life. The importance of such comparisons is that there is no way to compare births for one year with those from another without a temporal dimension. This point will be elaborated in the discussion of fertility.

The disadvantage of cohort measures is that they require a period of time to pass before they are complete. For fertility this means that the birth cohorts are for women born 45 years in the past. For education it means that the most recent cohort to complete high school were those entering the first grade 12 years ago. For mortality the time required is about 85 years. To overcome this drawback, it is fairly common to construct a cohort as a composite of a population. Such cohorts are usually called "synthetic cohorts." The number of births for the synthetic cohort group is the period total number of births and is obtained as the sum of the number of children born to women in each of the five-year fertility rates, i.e., for women currently 15-19 (born from 1956 to 1960) to women currently aged 40-44 (born 1930-1934). Of all the summary data for births, the total births, based on either a complete cohort or a synthetic cohort (as a period measure) utilizes the greatest amount of information and is the most desirable measure.

Perhaps the most successful of all demographic analytical tools is the life table or, as it is sometimes called, the mortality table. The life table traces the impact of mortality on a cohort of persons from birth to death and provides a dynamic picture of the changing probabilities of death. The life table starts with an initial population of 100,000 (or some other multiple of 10) and reduces this initial population from one age to the next according to a fixed schedule of mortality. At each age only the survivors are subject to the risk of death, and over the interval from one age to the next a proportion will be removed or "decremented" from the population until the entire cohort has been depleted.

Although there are two types of life tables, the generation life table and the period life table, the former is based on an actual cohort of persons and has less utility for most demographic and actuarial purposes because of the necessity of waiting until all members have died. The most recent generation life table is based on birth cohorts before the turn of the century. The period life table, on the other hand, is quite similar to the period total fertility in that it utilizes a synthetic cohort and is actually a cross-section of the current population.

The life table provides a wealth of information about the nature of mortality for a population. It produces a summary measure, the "expectation of life at birth" or the years of life remaining to persons still living at a specific age. It provides the proportions of the population who will survive from one age to another and forms a basis to estimate what the size of a cohort will be at some furture time. Therefore, it is an important aspect of making population projections and has been proved to have theoretical use in developing population estimates for nations with poor vital statistics and providing an important conceptual model in the area of stable population theory.

Aside from its use in obtaining population estimates and projections, the life table could have important applications for the educational planner which have not yet been exploited. The life table represents a specific application of a more general analytical tool, the decrement table. The life table is a single decrement table in that the population from one age to the next is decremented or decreased by a single probability. There are other applications of this technique which involve the removal of persons from a population over time through multiple causes. In the insurance industry much use is made of multiple decrement tables for calculating retirement premiums where the number of survivors to retirement are calculated as the proportion of workers who survive the combined probabilities of death, disability and change of employment. The multiple decrement table has also been used to analyze the rate of marriage where an initial single population is decremented by either marriage or mortality.

Although a school life table has been proposed, with an elaboration of most of its methodological aspects (Stockwell and Nam, 1963), it has not been widely utilized. It would seem that the use of school life tables for planning purposes would hold great potential. The school life table is a double decrement table which traces a cohort from age 5 to 35 through their educational careers, with the population from each age to the next being decremented from the enrolled population by the joint effects of mortality and withdrawal. The school life table provides information analogous to the mortality or life table in that it provides a summary measure of the number of years that an individual alive (enrolled) at a specific age will spend in the educational system either for his entire life or from one age to the next.

The school life table can be constructed for the entire population and can provide an indication of the extent of educational utilization for an entire population, or it can be constructed for the enrolled population only. The first would provide a measure of the extent that the entire population utilizes educational facilities by age, while the second would form a basis to analyze the progression of students through the educational system as a student flow model.

Tables could be constructed for different segments of the population to assess convergence and divergence between different sub-groups. Thus, separate tables could be prepared for whites, blacks, or other minorities, males and females, urban and rural residents. To the extent that each of these groups displays a different pattern of utilization, the school life table would facilitate comparisons. To the extent that there is a differential utilization by different groups in a population and these groups themselves are undergoing change (e.g., fewer rural students or changes in the proportion of minority students), the school life table could be an important tool for estimating future utilization.

The school life table, since it gives a picture of the changing patterns of enrollment by age, points out areas of change in educational utilization over time. For example, the tables constructed by Stockwell and Nam for 1950-1952 and 1957-1959 show that overall utilization increased by about 0.80 years for students in the first grade whose school life expectancy was 12.96 years in 1950-52. However, for 1950-52, the enrollment expectancy declined until age 18 and then increased, reaching a peak at age 27. In 1957-1959 enrollment expectancy also declined to age 18 and then increased, but it reached a peak at age 23. The difference between the two time periods was almost two years of additional educational use by enrolled persons aged 23 in 1957-1959.

With the increasing availability and use of data processing systems by education, the construction of school life tables could be easily incorporated into the routine processing and analysis of enrollment data.

MORTALITY AND EDUCATIONAL PLANNING

Of the three primary demographic components, mortality represents something of a paradox for the educational planner. It is the least ambiguous of all demographic events and was the first demographic process to undergo detailed analysis, which has given rise to the most powerful analytic tool--the life table. At the same time, mortality presents, at least for the United States today, the most predictable of sources of the dynamics of population change. To this general statement, however, two caveats must be added. First, the relative role of mortality in the dynamics of population change varies directly with the size of the territorial unit. For national units, or the world, the relative importance of mortality will be much greater than for small sub-national units where both fertility and migration play a much greater role. Second, the potential for rapid and large-scale change, while remote, is very real. Thus war, epidemics, and other disasters hold the potential to produce massive change in the size, structure and distribution of a population.

Historically, mortality has played a major role in determining population growth and structure. Indeed, for most of man's history mortality was the dominant demographic factor (Wrigley, 1969). Starting as early as the 16th century in Western Europe, there began an erratic downward trend in mortality levels which by the end of the 17th century had started to undergo a sharper and more linear decline (Stolnitz, 1955). The end of the 18th century witnessed a much sharper decline which continued to the point that, for contemporary western nations, mortality has approached an asymptotic upper bound and will undergo a much more gradual decline. Present knowledge would indicate that, barring some "act of God," there will be only slight changes in present mortality levels.

Levels of mortality are not uniform but vary considerably by age, with the very young and the old having the highest levels. The most concern in educational planning is for the younger ages, and it is at these ages that anticipated declines are generally regarded as more remote than declines for older persons. Most of the anticipated reductions in mortality will affect the population at the older ages. It appears that much of the mortality at the younger ages, especially the first few days or weeks of life where mortality is higher than at any other age until sometime after age 60, reflects congenital conditions which are not likely to come under medical control. The change more likely to take place will be at older ages, but even here there is not likely to be any sudden or dramatic change. It appears that the human life span is somewhere in the neighborhood of 100 years, and even if there were some revolutionary medical breakthrough such as the elimination of major cardio-vascular diseases, the resulting increase in longevity would probably be from about 67.6 to 78.3 years for white males and from 74.7 years to 85.7 years for white females (Preston, 1972).

Having made these general statements in reference to the United States in general, some specific exceptions should be noted. In many states there exist substantial mortality differences between segments of the population. Among the more substantial differentials is that between whites and blacks. Although a small amount of this differential may be attributed to genetic factors (e.g., sickle cell anemia), the overwhelmingly greater part is a result of a variety of social and economic circumstances, all of which combine to produce significantly higher mortality for blacks. In 1970 the average expectation of life at birth (e^0) for white females was almost 76 years of age, or about eight years more than for black females. The difference for males was also about eight years, but the higher overall mortality for males produced an expectancy at birth for white males of approximately 67 years. If the mortality differentials are examined relative to the number of infants who survive until age five, they produce a deficit of about 25 fewer black males than white males per 1000 births. For females, there are 24 fewer blacks than whites per 1000 births who survive until their fifth birthday.

Even these substantial differentials, as deplorable as they are from a humanistic perspective, are not likely to be a source of great variation for educational planning. Nor will these differentials be rapidly reduced; it is more likely that any diminution will take place gradually. Assuming, however, that these differentials could be eliminated quickly, the change would be proportional to the number of black births in the population. In those areas where black births comprise either a substantial proportion or a large absolute number of births, the impact will be much greater. Given North Carolina's present number of births for 1972, for example, the elimination of this differential would have produced an additional 672 survivors to age five.

FERTILITY AND EDUCATIONAL PLANNING

Demographically, the United States as it approaches the mid-70's stands at a crossroads. The birth rate was at an all-time low of 14.6 as of December, 1973 (HEW, 1974), while the number of potential parents is at a record high. The next decade will be one of the most important in our demographic history--perhaps even more important than the ten-year period following World War II. During the 1930's many demographers interpreted the declining birth rate as representing the final stage of a transitional process which would end in a balance between births and deaths, resulting in an era of population stability. The processes of urbanization, industrialization and a general secularization of society were seen as the causative agents.

Just as the forecasts of the political pollsters who saw Dewey defeating Truman proved wrong, those made by the demographic futurists were also wrong. With the entry of the United States into the war, the birth rate started to climb. By the end of the war the birth rate took a substantial leap and climbed steadily until 1947. The number of babies continued to increase until 1957 when a new record for births was recorded. The "baby boom" became a household word as the number of births soared. It was fully anticipated that these boom babies would start to reproduce themselves by the middle part of the 1960's. In fact, an authoritative article written as late as 1966 candidly claimed (Solomon, 1966):

> Shortrange, however, there is little likelihood of a further downswing in the birth rate. If anything the coming age of the boom babies will bring an unprecedented number of couples into parenthood, thus boosting the birth rate.

However, the birth rate continued to fall, reaching a low of 17.5 in 1968. By 1970 it had increased to 18.2, which was regarded as an indication that a period of high fertility was at hand; but the next year saw the birth rate fall again--a trend that has continued to today.

Many of the demographic factors involved in fluctations in fertility levels have only recently come under shophisticated analysis, and it is doubtful that much of this knowledge has been diffused into other disciplines. Many of these factors which have served to structure past demographic events are factors which also have important implications for educational planning. Some of the factors are of long-range concern, such as the ultimate size of the school-age population and possibility of future fertility being characterized by substantial short-term fluctuations as a response to transitory social and economic conditions. There are both short- and long-term considerations such as the extent that existing perturbations in the age distribution of the population will reproduce themselves with sharp fidelity. Another aspect is the extent to which the educational system is linked to fertility

levels. The timing of marriage and parenthood holds implications for those currently enrolled at the upper levels, for the new enrollees a few years hence will be children of those presently enrolled, and decisions made by the cohorts presently enrolled will greatly affect future numbers of students.

In order to understand many of the demographic implications of fertility for educational planning, it is necessary to focus on the dynamic aspect of fertility as a process. This process can be pursued from several perspectives: a biological process involving conception, gestation, and parturition; a micro-biosocial perspective dealing with coital frequency, contraceptive use, fecundity, and utilization of voluntary abortion; and so on. Another micro-perspective is concerned with the socio-psychological factors such as the decision-making process to have children, motivation to use contraceptives, and the relation between conjugal roles and fertility planning. Distinct from these considerations is a macro-perspective, which may deal with many of the same factors but does so in an aggregate form. Finally, there is what might be called a macro-demographic perspective, which would add to the preceding list of factors elements of population composition and structure. This presentation is concerned primarily with these macro-demographic factors and will rely on such factors as changes in the number of persons in the reproductive ages, the proportions married by certain ages, the distribution of births of different orders, the timing between marriage and birth of children, and the number of children born.

United States Fertility in Historical Perspective

When the first U. S. census was taken in 1790, there were approximately 3.9 million Americans. For the next few decades the fertility of American women fluctuated at a level approximating the biological maximum, between 50 and 57 births per 1000 population (Grabill, et al., 1959). The period from the early 1800's to World War I was one of a gradual decline in the birth rate yet, due to the increasing proportion of women in the reproductive years, one of increasing numbers of births. By 1933 the birth rate had reached an all-time low of 18.4. Over the next few years the birth rate fluctuated around 19.0, but by 1941 it started to increase. The first few years of World War II were a period of slight increase in the birth rate, characterized by fluctuations. By the mid-1940's, the slight increase had accelerated to a new modern high which leveled into a broad plateau which lasted into the early 1960's. In 1957 a new record was set for the total births in a single year. From the middle of the 1960's to the present, with the exception of 1970, the birth rate had declined.

The trend over this period from 1790 to the present is one of a gradual secular decline, marked by several periods of sharply fluctuating

fertility. Earlier it was pointed out that period measures for many demographic analyses are inferior to cohort measures. In fact, the transition from period to cohort analysis of fertility trends represents one of the major advances in demography since World War II. This is not so much because the benefits of a cohort approach were not appreciated as because of a lack of necessary data. Among cohort measures of fertility, the most useful is the number of children born to women who have completed their reproductive lives. Recently an analysis of American fertility has been described in a series of articles by Norman Ryder (1966, 1973a, 1973b). The following discussion of the trend in American fertility from a cohort perspective will rely greatly on the information contained in these articles.

In the early colonial period the total fertility rate is estimated to have been about eight children per woman (Grabill, et al., 1959). By the turn of the 20th century the number of children born per woman was about 3.75 for women midway through their fertility careers. For the cohort of women born in the period from 1876 to 1880, the number of children ever born per woman was about 3.74. Women born from 1891 to 1895 averaged 2.96 children. Each successive birth cohort completed their families with slightly fewer children until the cohort of 1906-1910, who completed their reproduction with the smallest number of children recorded to that time, 2.27. The women born in 1911-1915 picked up the pace slightly, having 2.32 children. Each successive birth cohort increased this value slightly up through the 1931-1935 cohort, who achieved the highest fertility of this century with 3.36 children. Information for the two more recent cohorts of 1936-1940 and 1941-1945, while not yet complete, indicates lower fertility. For women born in 1936-1940, their TFR is estimated to be 3.31, and the projected fertility for the cohort born in 1941-1945 is placed at 2.98. Over this period of 50 cohort years, the mean age of fertility (the average age of women at the time they are midway between their first and last births) was about 27.5 years until the 1926-1930 cohort, when it decreased to slightly under 27 years and further declined to just under 25 years for the cohort born in 1936-1940. If the midpoint of the interval for a birth cohort is added to the mean age of fertility, it provides a rough approximation of the time period when each of the cohorts was half-way through its reproduction and permits one to associate period events such as war and depression with cohort fertility. Thus, the birth cohort members of 1891-1895 were half-way through their fertility by the end of World War I, and the 1896-1900 cohort women were just starting their fertility at the same time. Similarly, the cohorts of 1911-1915 and 1916-1920 were half-way through their fertility in 1945 and 1950. The most recent cohort, born in 1941-45, was half-way through their childbearing years by 1970. From this perspective it can be seen that the cohort having the lowest fertility was the one born in 1906-1910, who were entering their reproductive years at the time of the Great Depression in 1930. It can also be seen that the fertility of women born 25 years apart increased by almost 50 percent from this depression cohort to the cohort of 1931-1935 (2.27 versus 3.36). In the ten cohort years from 1931-1935 to 1941-1945 the number of births per woman declined by .38.

There is another dimension to changes in the fertility of women over this 50-year period. While the cohort born in 1897 had an average of 2.96 children, and the cohort born in 1931-1935 had 3.36 children, these values reflect different parity distributions. Of women born in the earlier period, 33.4 percent finished their fertility with zero or one child, while of the cohort born in 1933, 13.9 percent finished with either one or no children. For women with five or more children, the proportion dropped slightly between these two periods--14.8 percent in the earlier period and 14.0 in the latter. Between the 1897 cohort and the depression cohort of 1909, the percentage with fewer than three children went from 54 to 64, and the proportion with two or more children declined for each parity.

Seen in this perspective, one of the major changes which took place over this period was an increase not in larger families, but in the proportion of couples remaining childless or having one child. In other words, the increase in births responsible for the high fertility following the war was a convergence on a completed family size of two, three, and four children. The women having births of the first three orders increased from 86 to 92 percent, and the number having more than three children declined from 70 to 61 percent.

Tyder (1966, p. 106) estimated that a 50 percent reduction in births above the third order, holding the lower three parity distributions constant, would produce only a 10 percent reduction in the total fertility for the more recent cohorts. That is, from the perspective of the number of women having births of different orders, the present fertility level is such that any dramatic reduction in contemporary fertility will have to be achieved through a reduction in the parity distributions of births of the first three orders.

The number of births per woman and the parity distribution of births within a population are but two aspects of fertility. Both are important dimensions, and the value of these two parameters determines the number of children born. However, there is another aspect to fertility, in many respects of greater importance for planning purposes. Ryder calculated that over the 50 cohort years from 1920 to 1970 the number of births for each cohort accounted for only 57 percent of the number of births registered in any year. The remaining 43 percent of period fertility was due to timing considerations. Timing, or tempo, parameters refer to the interval from marriage to the birth of the children and the age when women marry. For reasons that will be developed later, it is felt that tempo considerations will play an even larger role in structuring fertility levels in the coming years.

In order to understand the relation between timing and period fertility, a few simplified examples will be provided, and these will be used to shed some additional light on contemporary and historical fertility. For simplicity, assume that there are two populations, identified in all respects except the age when women have their first

child. Mothers in one population have their first child when they are exactly 20 years of age. They have two additional children, each born exactly five years apart. In the second population, women also have three children spaced five years apart, but they have their first child when they are 30 and are, therefore, ten years older at each birth than women in the first population. Assuming that mortality is zero for both populations, each has a cohort TFR of exactly 3.0. However, the period fertility of the first will be higher than the second. That is, the number of births in any given year as a proportion of the number of women will be higher for the first. To illustrate, women born in 1950 in the first population would have their first child in 1970, their second in 1975, and their third in 1980. By 1990 the daughters born to these women would begin to have their children, while the daughters born to the birth cohort of 1950 in the second population will not start to have their children until 2000. If this difference were to be maintained, the same pattern would be repeated for each successive generation. The only difference between these two populations is what demographers call the mean age of childbearing or the length of a generation. It is defined as the average age of the women at the birth of their children.[1] In the first population the mean age of childbearing is 25, and in the second it is 35.

Consider a second example, using the previous hypothetical cases, of how tempo considerations affect period fertility. Suppose for a variety of reasons that women in the first population were to have their children at the same ages as women in the second. Period fertility would initially fall to zero and would remain there for 10 years. Although the cohort fertility for the two populations would be the same, the period birth rate for the first would be zero, since there would not be any births for ten years.

These are, of course, greatly simplified examples, and in actuality there would be other differences between the fertility of the two populations even assuming that the mean age at childbearing was different by 10 years. First, women who are older when they start their childbearing will have fewer children, for mortality increases with age and fewer women will survive to finish their families. Secondly, the likelihood of conception is not constant but declines with age starting about the 35th year. Older women would, therefore, be more likely to experience a lower physiological capability of conception.

Much of the period fertility levels from year to year over the period from 1920 to the present can be discussed in terms of several

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[1]More accurately, the mean age of childbearing is the average age of the woman at the birth of daughters rather than all children. This distinction is made for analytical simplicity, since most analyses of reproduction deal only with females and not both sexes. In actuality, however, it is doubtful that there is any difference between an average age based on female births rather than all births.

influencing factors. The period from 1920 to 1940 could be characterized as a period when the age at fertility was rising. The rising age at childbearing had the effect of exerting a downward force on period level fertility since births were taking place later in life during each of these 20 years. The second major trend was the reversal of the rise in the mean age of fertility which began in the middle of the 1940's and continued to the middle of the 1960's. Over this time period the mean age of fertility decreased by almost two full years. The effect of this decline was to shorten the time base for the period fertility over this interval and produce an upward boost for period fertility rates.

A second aspect of the period fertility from the depression until the end of World War II was the postponement of births by the younger depression cohorts. These postponed births arrived at a time when the pre-war birth cohorts were starting to have their families. The high period fertility in the late 1940's was produced by several cohorts who did not differ a great deal in terms of their completed fertility but were able to produce a large number of births in a fairly short time period.

The recent downward swing in the birth rate can also be partly explained in these terms. The younger cohorts for which there are available data indicate an upward turn in the age of fertility again. This upward trend has had a downward force on the present period fertility. The mean age of fertility for the 1941-1945 cohort is about 0.5 years higher than the preceding cohort. Aside from cohort considerations, the proportions of the population married at a younger age is declining. For females aged 15-19 the percentage married in 1970 was 11.9 percent, the lowest in over 30 years and over five percent lower than the high of 17.1 in 1950 (an all-time record). Since the age at marriage is the prime determinant of the age when fertility starts--and to a considerable extent the total completed fertility--the recent upswing in the age at marriage exerts a downward pressure on period fertility even if the younger reproductive cohorts finish with the same number of children that their mothers had.

Transitory period phenomena affect different reproductive cohorts in different ways. For example, a period-specific event such as a depression will affect younger cohorts by delaying marriage and, if married, by increasing the interval from marriage to the first birth. For cohorts who are slightly older, an increase in the interval serves to restrict parity progression directly with age. Thus, younger couples at parity one may postpone the second birth for a considerable time and then resume a fairly high progression ratio to the second parity, but with advancing age the progression ratios to higher-order births will be diminished. For couples with two children, the delay will more likely end in a termination. Ryder interprets the effect of a transition from prosperity to depression in this manner. The general

strategy for coping with a new situation is to select the alternatives having the least consequences first and the alternatives having the greatest consequences last. The history of timing and parity progression for the depression indicates this general pattern. The first strategy was the minimal one--a delay in marriage--followed by a delay in the birth of the next child and, finally, the action having the greatest consequence--a reduction in the number of children. This pattern would suggest bases on which to monitor changes in fertility patterns. The first is the proportion married at a younger age, next the interval from marriage to first birth, and finally, the progression ratios for the second and higher parities.

Birth Expectations

Although cohort fertility provides the best picture of actual fertility levels, it suffers from one serious handicap; childbearing can take place over a considerable length of time. The women who comprise the group of greatest concern for future fertility are those at the younger ages. Yet it is these women who have the majority of their reproductive lives in front of them, and the length of the interval from present age until the end of reproductive potential comprises the greatest source of uncertainty. For the cohorts of the most immediate concern such as 1946-1950 and 1951-1955, the open period is roughly 20 and 25 years. Since it is desirable to be in a position to estimate what the fertility of these women will be, at least for the more immediate future, and since period fertility from one year to the next is a poor basis to estimate future fertility, there has been reliance on data indicating what the expected fertility will be. This technique is stark in its simplicity--the women are simply asked how many children they plan to have. The first studies to utilize this approach for obtaining a means to assess the future course of fertility were the Growth of American Families (GAF) studies which were conducted in 1955 (Freedman et al., 1959) and in 1960 (Whelpton et al., 1966). The 1960 study had as a primary objective to follow up the expected fertility obtained in the earlier survey. The first study sampled married white women between the ages of 18 and 39. The women in the earlier study were asked, among a host of other questions, how many children they intended to have within the next five years. The women interviewed in 1955 expected on the average to have between 0.90 and 0.93 births. The follow-up study based on a different but matched group of women in 1960 found that the births over the preceding five years averaged 0.92 births. In 1964 the use of birth expectations was included as a technique for making population projections by the U. S. Census Bureau. In the 1955 study women aged 18-24 expected the largest families, 3.2 children. In 1960, the women aged 18-24 expected the smallest number of children, 3.0. The most recent survey data (U. S. Bureau of the Census, 1972a) indicate that expected fertility for this age group had declined to 2.4. Thus, in a period of less than 20 years expected fertility for the younger cohorts of women has declined by 0.8.

Differentials

To focus only on the total number of births or the trend in birth rates over time is to ignore another dimension of fertility having relevance for educational planning. The extent that a population is comprised of different groups having differential levels of reproduction and, therefore, different potentials for change provides another source of variation. This variation is even more important for populations having significant proportions of their total numbers in these different groups. Insofar as the composition of the population changes with respect to group characteristics, an additional source of change must be considered. Although there are many criteria for delimiting a segment of the population, a primary one for the educational planner--is ethnicity.

Much of the discussion which follows is based on material in the 1965 Fertility Study (Ryder and Westoff, 1971). A follow-up to this study was conducted in 1970, and a report will be released soon. For the nation as a whole, based on a probability sample of 5,617 married women between the ages of 18 and 45, there were significant differentials between blacks and whites. White women under age 45 expected to have an average of 2.6 births.[2] This was .7 of a birth lower than blacks in the same period who, on the average, expected 3.3 births. The expected family size differential for these two groups was also 0.7, with blacks expecting a final family size of 4.0. These values reflect responses to questions about the numbers of children expected. When the women were asked what would be the number of children they would like to have if they could relive their lives, the desired numbers were almost identical, with blacks desiring 3.2 children and whites desiring 3.3 children.

The difference between the expected and the desired numbers of children in the above study reveals the extent that additional children are not planned. The difference between the expected and desired number of children for blacks indicates little planning error, but the difference for whites amounts to a little less than one unplanned child per woman.

When educational differences are examined in relation to fertility for blacks and whites, some rather strong relations are found. For black women with less than any high school education, the expected family size was 5.2 children, which is over twice the number expected by black college graduates (2.3). White women college graduates expected 3.0 children, while those with no high school education expected 4.1 (Ryder and Westoff, Table IV-1).

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[2]The completed fertility here will be lower than those discussed earlier. The difference is that these values are for married women, while the earlier discussion was for all women.

If education is not considered but the age of the women is used to cross-classify the fertility differentials, women under age 25 showed similar expectations, with blacks expecting slightly fewer children than whites (Table IV-4), which reflects the extent that the younger black cohorts have made gains in their educational attainment.

For the educational planner in the South, one differential is of particular importance. The strongest differential to be found among all the women is the one which occurs between white-collar black females and those who are presently living on a southern farm. The expected births for the former is 2.8, while for the latter it is 6.0. When residence alone is considered there remains a substantial racial difference, with blacks who had never lived on a farm expecting 3.5 children compared to 3.2 for nonfarm whites. Blacks who had at one time lived on a southern farm expect to have 4.1 children, but those presently living on a southern farm expect to have 5.7 children.

The transition from the rural areas to the urban centers is also tied to substantial fertility differentials. For whites living in the 14 largest metropolitan areas, the expected number of children is 3.1, while for similarly situated blacks, it is 3.2. For women living in central cities of 50,000 to 150,000 population, the differences are more substantial; blacks on the average expect 4.2 children while whites expect 3.5.

When socioeconomic factors are considered, the fertility of blacks again shows sharper variation than that for whites. Black families having a husband's income of over $10,000 expect 2.6 children, which is almost half the 5.1 expected by black women whose husbands earn less than $3,000 (Table IV-5). Although there is a differential for whites similarly situated, it is much less (3.1 and 3.5, respectively). If family income is used as an indicator of socioeconomic status, a sharper differential is obtained. Black women having a family income of over $15,000 expect 2.1 children, while black women with a family income of less than the poverty level expect 5.3. Again the differential for whites is less--3.0 for those with a family income over $15,000 and 3.9 for families below the poverty level. However, this differential cannot be attributed solely to income, for many of the blacks in the lower income levels are those with recent rural farm backgrounds.

One other differential must be mentioned. Women who either work or have had work experience evidence a difference in the number of children expected. Whites who have never worked expect a family size of 3.7; for blacks it is 4.5. For whites who once worked, the expected number of children was 3.3 and for blacks, 4.0. For those who were currently employed at the time of the survey, whites expected 2.9 births and blacks 3.6. Among these differentials, an additional distinction can be made. If only those currently employed are considered, those

giving the reason for working as a need for money expected 3.1 and 4.3 births for whites and blacks, respectively. However, when those who work responded that they enjoyed working, the expectations were 2.6 for whites and 2.4 for blacks.

Care needs to be exercised in interpreting these differentials, for it is not clear how much of the lower fertility expectations can be attributed to employment as effect and how much as cause. While working may help to induce lower fertility, a number of women may work because of reproductive impairments which provide more freedom to work.

One additional aspect of fertility as revealed in this type of approach will be mentioned. Ryder and Westoff made an analytical distinction between "wanted" and "unwanted" births. The significance of the difference between the two levels is that the excess between what is actually wanted and that which is expected is frequently taken to provide a rough measure of the extent that better family planning, primarily in the area of birth control, could be expected to reduce fertility. The difference between the expected number of children and the number desired provides a rough index of current failure among couples to reach successfully their productive goals. The phrase "unwanted children" refers simply to the fact that before conception the couple were not trying to have another child, and does not imply that the child is necessarily unwanted or unloved after birth.

The most salient aspect of an analysis of "wanted fertility" is that many of the differentials which were discussed above are greatly diminished on this scale. Of special note is the fact that "wanted" fertility among black females is almost universally lower than "wanted" fertility among whites.

A few examples will be given of the levels of wanted fertility classified by race and other factors. First, for women under age 20 the wanted fertility for whites is 2.6, while for blacks it is 2.5. For women aged 20-24 the wanted rates are 2.7 and 2.5, which represent .3 and .4 fewer births than those expected. By education some truly remarkable differences can be noted. For college-educated women, whites express a wanted number of births as 2.8 (.5 less than expected births), while black college graduates claim they want 1.9 children on the average, or almost one child less per woman than expected. When those with less than a high school education constitute the sample, white females express a value of 3.2, while their black counterparts claim a wanted number of 2.9. This 2.9 figure is 1.1 child less than expected. By income the same relationship holds: whites in the highest category ($15,000 and over) want 2.7 children, and the value for blacks is 2.0. For both groups the difference is .7 birth under the expected number. For the lowest income level, whites claim a value of 2.9 and blacks, 3.1. Again, both are lower than the expected number, this time by .8 birth.

Although expectations have been fairly accurate indicators of actual fertility over a short time span, prior agreement is not a guarantee of continued correspondence. The notion of "wanted" fertility is even less secure, since its verification is impossible. Ryder (1973a, p. 60) sums this up well:

> It is true that data on desired family size have roughly paralleled the movements in total fertility, but we think it a moot question which could be regarded as cause and which effect. It would seem at least plausible that such questions would yield a compound of fantasy before the fact and rationalization after the fact.

Discussion

The preceding material has been long on description and short on discussion. This section discusses some of its more salient aspects. One of the major trends presented was a gradual secular decline in completed fertility. We must warn against projecting continued declines too far in the future. There is no evidence to suggest a dramatic reorientation toward the number of children considered ideal by the recent cohorts for which data are available. Fluctuations in completed fertility are seen by many demographers as the result of fairly stable reproducitve norms operating within the situational context of the time when fertility took place. The major development in completed family size has been a process of convergence on these norms. Fewer couples have had large families, but fewer couples have remained childless or had only one child. This convergence to a smaller range in completed fertility is perhaps the most significant aspect of fertility for many planning considerations. The convergence on a smaller range of births for larger proportions of the population should <u>not</u> be construed as indicating a convergence of period fertility for the forseeable future. In fact, the convergence to a smaller range of children will likely lead to greater instability in period fertility.

Declines in "unwanted" fertility represent the major shift which has facilitated the convergence from higher birth orders. The principal factors involved in this trend have been the increased availability and utilization of improved contraceptive techniques. Recently, two additional developments have taken place which should augment gains in contraceptive efficacy: greater availability and use of voluntary sterilization and abortion. Each of these is a fairly recent development, but it seems plausible that the net effect of both will be to decrease even further the levels of unwanted fertility among the younger birth cohorts who either are starting their families or will do so in a few years.

Another aspect of cohort fertility is the inverse relationship which has obtained historically between cohort size and completed

fertility (Ryder, 1973b). Cohorts experience greater competition from other cohort members as the relative size of the cohort increases. Much of this competition takes place at the time of entry into higher education, a most important period in regard to marriage and family formation. Entry into higher education is more problematic for a member of a larger cohort, as is finding a job or being promoted, all of which are prerequisites for the accumulation of resources that family formation entails. In this respect it is interesting to note that the present cohort aged 15-25 represents one of the largest proportions of the total population in recent history. In absolute numbers, this cohort is the largest ever.

An additional factor which has both long- and short-range implications for the fertility of the younger reproductive cohorts is the extent of female labor force participation. While it is impossible to determine how much change has occurred in the fundamental orientation of women toward employment, especially in terms of career employment, increased employment at the younger ages will have the effect of increasing the mean age of fertility, even if reproductive levels on a cohort basis are maintained. Such an increase in this parameter will, as was pointed our earlier, exert a downward force on period fertility. Aside from a strictly mathematical relationship, a rise in the mean age of fertility will tend to depress cohort fertility because of increased mortality and conception impediments.

While these are important considerations for understanding the course of fertility for the immediate future, a major characteristic of future fertility is likely to be fairly sharp fluctuations in the number of births over any given time period. The two parameters which augur these fluctuations have already been mentioned: the extent that the population is homogeneous with respect to completed fertility and the age of women at the birth of their children. For the fertility from 1920 to 1970, it was pointed out that timing or tempo parameters accounted for 43 percent of period fertility levels. If the convergence to a smaller range of parities continues for the younger reproductive cohorts, the future period fertility will be determined to a greater extent by timing considerations.[3] To the extent that couples are better able to plan completed fertility--that is, to exercise control over the numbers of children born--they have greater control over the time period in which they will have children. With increased control over fertility there is a greater likelihood that many reproductive decisions will be made as a response to situational exigencies. The net effect of this will be to make changes in period fertility more dependent upon changes in the social and economic environment. In a more limited sense this notion has led to considerable interest in the economics of fertility which posits a direct relation between income and

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[3]The limiting case here would be a hypothetical population in which all couples had the same completed fertility, in which case period fertility would be completely determined by tempo considerations.

fertility for a population having perfect fertility control (Becker, 1960; Easterlin, 1966; Blake, 1968; Hawthorn, 1970).

Aside from these micro considerations which take period fertility as an aggregate of individual decision-making processes, there is a macro relationship between the homogeneity of a population and its long-range characteristics. A population which is homogeneous with respect to its fertility patterns--especially first and second parities, since these represent a large proportion of fertility in any given time period--will tend to be characterized by sharp fluctuations in its period fertility because of perturbations in its age structure. For every "bulge" in the population in the reproductive years there will be a corresponding "echo" in the birth rate. The "boom" babies represent such a perturbation in the present age structure, and it is the "birth echo" from these couples which has been anticipated to increase the birth rate. There are two parameters which dampen this echo. The first is the level of mortality, and the second is the homogeneity in the timing of children, especially the first birth. Since the mortality parameter in this process is relatively minor for the United States, it will not be discussed here. Interested persons with some mathematical background can find a complete development of it in Coale (1972) or Keyfitz (1968).

The echo will materialize over the period anticipated to the extent that the younger cohorts are homogeneous with respect to the birth of their children. Given that the entering reproductive cohorts are not homogeneous--that is, that there is a high variance in age at the first birth--the echo from the boom babies will be dampened. For each successive generation the amount of heterogeneity will serve to dampen it even further.

These parameters hold more than idle theoretical interest for long-range planning, for the homogeneity of timing will determine the extent to which there will be a gradual transition in the utilization of educational facilities from one level to the next. If timing patterns are heterogeneous and completed fertility remains stable, the proportions enrolled in any one level will not differ substantially from those at another level. If a population becomes more heterogenous, the period over which this process takes place will be of prime importance. A sharp increase lasting a few years could be handled by reallocation from other sectors of the educational system. Increases lasting longer, especially those of longer duration than the time span required for a cohort to pass from one level to the next (e.g., more than six years), could possibly indicate the need for additional facilities and personnel.

One note of caution must be made. For planning purposes, especially those involving the horizon beyond the next few years, present fertility levels or those observed over a short period of time are likely to be poor indicators of future contingencies. Even from a

cohort perspective no amount of analysis can mitigate the fact that reproduction can, and often does, take place over a considerable period of time. To the extent that this reproductive potential is necessarily in the future, it is a constant source of uncertainty. Demographers have been wrong in the past in their speculations about future fertility, and they will be wrong in the future; but they have also been right in the past, and they will be right in the future. The real progress is that in the past they were frequently right for the wrong reasons, while today they may be wrong for the right reasons.

MIGRATION AND EDUCATIONAL PLANNING

While mortality and fertility are biological events, each has a cultural component. To the extent that suicide and other cultural factors such as advances in medical technology shorten or prolong life, mortality contains an element of cultural choice. Likewise, the decision to use contraceptive techniques or to delay marriage represents elements of cultural choice affecting the fertility rates of populations. Migration, however, is a purely cultural event--a product of human decisions, not human biology. Regardless of where, when or how a person moves, the "why" of his moving is related to either a choice on his part or the decisions of others who force the move. If we observe that mortality is least affected by cultural choice and fertility affected more greatly, we may also observe that difficulties in making general statements about these factors increase as the component of cultural choice increases. It is not difficult to infer from this that migration, as a purely cultural event, will present the greatest difficulty in terms of demographic explanation of any of the factors associated with population growth and distribution. Perhaps even more significant for the educational planner is the fact that the difficulty of comprehending migration increases as smaller units are considered. In general, the smaller the unit area to be considered in terms of migration, the greater the difficulty there is in obtaining adequate data and the greater the potential magnitude of error. Finally, it is at the local level, where the task of assessing migration is likely to be most difficult, that there is the least likelihood of the existence of trained personnel to undertake such demographic studies. This section of the paper attempts to point out some of the problems in migration research, outline briefly some methods of determining migration patterns, and provide a summary of migration and present population distribution in America.

A human being may experience birth and death only once, but between those two events any individual is in a constant state of movement. Since migration is concerned with part of this human movement as it affects the redistribution of people on the land, the first task of the demographer is to define relevant levels of analysis for human migration. For instance, on any given day the population of any central city area may fluctuate wildly. At 5:00 A.M. it may be relatively small; by 12 noon it is swollen with the rush of shoppers, executives, laborers and a host of working people at their jobs; and finally by 9:00 P.M. the population may have declined only slightly from its midday high but changed its composition totally. This cycle of activity--predictable in terms of rough size and general population characteristics--may take place in any city and on any given day, but it is not on a level of particular interest to the study of migration. The study of migration is not the study of the temporary movement of people to and from their jobs or shopping, but the study of their residential mobility. For the demographer, residential mobility is defined as "any change of usual residence that involves movement from one structure

(house, apartment, hotel, barracks, dormitory, etc.) to another" (Bogue, 1969, p. 752).

Within this broad definition of mobility, we may recognize two analytically distinct classes of movers--the local movers and the migrants. The distinction between these two classes may become of the greatest relevance for planners, particularly at the local level. For purposes of analysis the factor distinguishing movement from migration, or the mover from the migrant, is the crossing of a political boundary. In the United States, the county level of administration is the arbitrarily chosen political boundary separating migrants from movers. Any change of residence within a county is called movement; any change of residence which entails crossing a county line is called migration. (As a technical aside, a few major cities have been deemed "quasi-counties" for purposes of migration research, and, hence, some movement from a central city area to its outlying county area and vice versa is considered migration.)

The proportion of movers to migrants is of special interest to the planner since it presents a major difficulty in data collection. An analysis of the 1960 U. S. Census indicated that of more than 75 million residentially mobile persons, a full 63 percent were defined as local movers. Of the remaining 37 percent defined as migrants only about one-half changed their state of residence. For the 1960 census information 82.1 percent of all residential mobility affected population redistribution within states rather than between states. The bookkeeping problems in connection with monitoring this population redistribution are considerable, particularly at the local level. It is entirely conceivable that subcounty units, such as school districts, could change drastically in terms of population, while the overall population of the county remained roughly the same. While the calculation of migration rates is not a difficult task, the quality of data decreases as the area of collection becomes smaller. For instance, obtaining a record of births and deaths by county may be relatively easy, but to obtain the same data for a school district is a major bookkeeping operation.

There are two methods for obtaining migration data--the <u>direct</u> method and the <u>indirect</u> method. The direct method entails the actual registration of persons who change their place of residence. In the U. S. the decennial census represents a source of direct migration data, though it is collected at relatively large intervals. Some countries--the Scandinavian nations, for example--maintain a continuous population register for their inhabitants. There are other sources of direct data on migration in the U. S., but these do not reach every citizen. County tax rolls, municipal street directories, utility company records, and state automobile licensing and registration divisions all contain information which might be useful in obtaining direct migration data. However, the quality of such data would be suspect since not all persons would be registered with any of these sources. For school-age populations, the local school districts themselves maintain direct data on

place of residence which could be exploited for purposes of analyzing migration, and this is a source of data which has not been used to its potential. Even mobility within a county--a subject untreated in studies of migration--might be detected and analyzed through information currently available to school districts at the local level.

If direct data on migration can be obtained, the calculation of migration rates is a relatively simple process. The general formula for the calculation of a net migration rate is:

$$\frac{I - O}{P} x\ k$$

where I is the number of in-migrants, O is the number of out-migrants, P is the population of the area at the midpoint of the time interval being calculated, and k is a constant, usually 100 or 1000. Because migration rates like other rates may be calculated for specific populations, it may be possible for school systems to use their own local data to calculate migration rates for school-age children, or even for cohort groups. Here caution should be exercised to ensure that the population at risk is consistent in the calculations. One would not use the total county population as the denominator in an equation which had as its numerator the difference between in- and out-migrant school children. Additionally, differences in fertility within the families of migrants would have some affect on these calculations. In a small school system the entrance or exit of several large families might have a considerable effect on the migration rate obtained. Bearing these warnings in mind, it may still be possible to obtain useful migration rates from local data.

There are three methods of obtaining indirect data on migration: the <u>place of birth</u> method, the <u>survival ratio</u> method and the <u>vital statistics</u> method. The place of birth method is applicable only to relatively large areas and is, therefore, of lesser interest to educational planners. It consists simply of comparing the place of birth of any individual to his place of residence at the time of questioning. Obviously, since place of birth is specified generally by county or city, it cannot be used to detect local movement. Furthermore, it identified neither persons who have migrated and later returned to their city or county of residence nor multiple moves. Consequently, it appears this method would be of relatively low utility for educational planners.

The survival ratio method may be used to determine net migration rates between censuses or, more broadly, between any two periods of population enumeration. This method simply multiplies each age group enumerated in one census by a survival ratio to obtain an estimate of the number of persons expected to be alive in any given area at the time of the next census, assuming that no migration has taken place. At the time of the second enumeration, the expected number of survivors

is subtracted from the actual number of persons enumerated to achieve an estimate of net migration. Thus, $M_i = P_t - P_{os}$ where M_i is the net intercensal migration, P_t is the number of persons in the last census enumeration, and P_{os} is the number of persons in the previous census multiplied by their survival ratio. It should be noted that this calculation must be completed for each age group, and allowances must be made for the fact that survivors grow older during the intercensal period. For local planners, a variation on this survival ratio technique may prove to have some interest. It is conceivable that reasonable estimates of net migration rates for school-age populations could be obtained by using a combination of school records and the life table suggested earlier in this report. The life table would provide survival ratios for classes of students which could be applied to varying periods of school enrollment data to yield migration rates for school-age children. Obviously, great care would have to be exercised in using this type of data since it would necessitate assumptions, such as uniform fertility rates.

The vital statistics method of obtaining net migration data should be of interest to state-level planners or to persons needing migration data at the county level. Using this method, net migration may be calculated by subtracting the number of births and deaths during an intercensal period from the total change in population during the same period:

$$M = (P_t - P_o) - (B - D).$$

Simply put, reproductive change is subtracted from total change to yield net migration. This method is less likely to be useful at the local level where birth and death statistics would be more difficult to obtain.

This brief treatment of methods of obtaining migration rates provides only a guide to the possible selection of techniques. Persons interested in actually calculating migration rates should refer to any of the standard texts on the subject. (Shryock et al., 1973, developed an excellent compendium of demographic methods.)

Migrants and Migration

The redistribution of human residence patterns which we call migration, or movement, has been taking place for as long as man has been able to walk. Yet, with more than a million years of migration experience behind us, we have yet to establish a satisfactory general theory to explain why migration takes place. At present, the most generally accepted model of migration is one which has been called the "push-pull-obstacles model" (Bogue, 1969). In broad outline, this model, suggested by Lee (1966), views individuals as responding to a set of

push and pull factors in their environment. In general, social, economic and demographic factors in the area of residence are seen as providing the "push." Factors such as loss of employment, discrimination, declining opportunity, or local catastrophe may operate singly or in combination to create dissatisfaction with the current place of residence. Other places exert a "pull." The bright lights of the city, the opening of a new plant in another state, or, in an earlier time, the discovery of gold in California all represent pulls. In theory it is the combination of these pushing and pulling factors which lead any individual to migrate.

If migration were simply push and pull, it might be relatively simple to predict the rates of migration from a general knowledge of the characteristics of an area. Areas which rated high in push factors would have high out-migration; areas with high pull factors would have high in-migration. It is the concept of obstacles which mars this neat picture. The family which loads its possessions into a car in New York, heads for Los Angeles, and runs out of both gas and money in St. Louis has struck an obstacle. If the "pull" of Los Angeles is strong, the family may stay in St. Louis long enough to earn money for gas and continue, but they may just as easily decide that St. Louis is far enough to go anyway and settle down permanently. Similarly, the black tenant farmer may view his rural homeland as a hell and the streets of New York City as a mecca--but lacking the price of a bus ticket, he may live and die within a few miles of his birthplace. Not all obstacles are negative, and many may represent opportunities. A man from Boston who is looking for a job in Chicago may incidentally hear about a better opening in Dallas. Dissatisfied rural people who decide to move to a major urban center like New York or Washington may elect to stop over in a smaller regional center first and, after finding a job, settle permanently.

As a general statement of the reasons why people move and why they settle in a particular area, the push-pull-obstacles model seems quite satisfactory. Unfortunately, it is not the type of model which is easily convertible into a predictive model of migration behavior. Decisions to move are largely the product of individual choices--excepting perhaps the movement of military personnel who may be ordered to migrate--and the mix of pushes and pulls affects different people to different degrees. The pattern of factors and their differential effects on human beings are easily noted in migration statistics. For instance, in the decade of the 1960's the southeastern United States experienced a heavy out-migration of blacks and a substantial in-migration of young adult whites. It would seem apparent from this that the different population segments were responding to different push and pull factors.

If we do not have available a model of migration which lends itself easily to the prediction of migration rates, we have at least a considerable body of historical data from which a number of broad trends in migration may be observed. The historical trends of American migration are so well known they scarcely need mention--the "metropolization"

of the U. S., the out-migration of blacks from the South, and the westward migration--yet these three general trends represent three classes of phenomena which may be described in present migration trends. In order to understand current patterns of migration, we must look at the characteristics of the migrants, the geographical patterns of migration, and the characteristics of places the migrants are coming from and going to.

Biological and Social Characteristics of Migrants

One of the most important characteristics of migrants from the point of view of the educational planner is their average age. In general it appears that the highest level of mobility is maintained by young adults--those between the ages of 18 and 34. Another highly mobile age group consists of children under six years old. The least mobile age groups are children between the ages of 10 and 18 and adults over 40. The patterns of mobility are similar for both local movers and migrants in each age group and generally similar for males and females. The correspondingly high rates of movement for the 18-to-34 and under-six groups, coupled with the fact that migration rates for males and females in these groups are quite similar, allow us to suggest that young families are the most mobile Americans. The drop in migration rates for persons over 40 and between the ages of 10 and 18 indicates as well a certain stability for established families with school-age children.

There are racial differences in mobility patterns as well. In general, the rates of mobility are higher for non-whites than for whites; however, mobility patterns differ substantially by race with respect to movers and migrants. In 1969, for instance, white Americans had a mobility rate of 18 per 100 compared to 21 per 100 for non-white citizens. The local mobility rate for non-whites was substantially higher than for whites, with a rate of 16 per 100 compared to 11 per 100. Migration rates by race showed a reverse pattern, however, with whites migrating at a rate of 7 per 100 compared to only 4.5 per 100 for non-whites (Morrison, 1972). These relatively low migration rates for non-whites may appear surprising in view of the exodus of the black population from the southern regions of the U. S., but in fact the continuing migration of blacks from the South has resulted in a situation in which the preponderance of the black population is now concentrated in the major metropolitan areas--mainly in the North. The history of black out-migration from the South reveals a pattern of generally steady increase from 1870 to 1950 (with the exception of the depression decade) and a dropping off from the late 1950's through the 1960's. One of the trends which might be looked for in the future is for the relatively low migration rate of non-whites to rise as blacks in metropolitan areas begin to suburbanize, as their white counterparts are doing at present.

Some differences may be noted in the mobility of persons in different employment categories. Professionals have a very high rate of mobility--21.5 per 100--compared to a low rate of 5.7 per 100 for farm managers and farmers (Morrison, 1972, p. 292). As of the 1970 Census, it appears that as a group manual workers are most mobile, followed by white-collar workers, service occupations and farm workers, in that order. Education level also appears to affect mobility, though its effects are more pronounced in migration rates than in local mobility. While local mobility for all educational attainment levels varies around a rate of 9 per 100, the likelihood of migration increases directly with the educational level. The migration rate for persons with an elementary education is 3.4, while for those with one or more years of college it rises to 8.3.

These factors of age, race, educational attainment and employment status, together with other known relationships, can help to build a picture of the characteristics of people who are more or less likely to move. The next step is to examine the geographic patterns of migration in an effort to determine where the migrants are coming from and where they are going.

Geographic Patterns in Migration

The most famous demographic episode in American history was the westward expansion. In a little more than a century from 1790 to 1900, the population of the U. S. grew from a mere 4 million persons concentrated along the Atlantic seaboard to over 72 million dispersed across the entire continent. With the passing of the frontier, however, the migration picture changed somewhat. There is still a westward migration, particularly toward California and the southwest, but it is no longer so pronounced. Where the early years of U. S. development were characterized by migration into frontier regions, there is now a redistribution of populations among much more mature demographic regions. Table 1 shows the net migration rates per 1000 population for the last century in the U. S. A brief table such as this is helpful in demonstrating certain general trends, such as the overall decline in the westward migration rate, but it does not demonstrate the changing nature of the regions. For instance, the northeast region has continually shown a net in-migration, yet over the past century the components going to make up that migration rate have varied considerably. For almost all decades since 1870 the northeast has had an out-migration of native born white populations which has been balanced by a heavy in-migration of blacks and foreign-born whites. The north-central region has had a very similar experience. The South has shown a net out-migration for all decades in the past century under the influence of a steady stream of out-migration of both black and native-born white populations. However, at the 1970 Census the situation had changed quite radically, with the South showing a net in-migration of whites which very nearly balanced the continuing heavy black out-migration. The steady westward migration--though continuing--appears to be slowing, and both blacks and whites are contributing to this lowered migration rate.

Table 1. Net Migration/1000 Population Between Ages 25-44 at End of Decade, 1880-1970

Region	1880-1890	1900-1910	1920-1930	1940-1950	1950-1960	1960-1970
Northeast. . . .	127	157	95	6	17	48
North Central .	91	30	30	-12	7	11
South	-13	-3	-65	-62	-56	-1
West	546	530	251	283	214	151

Source: Taeuber, 1972, p. 49.

The population redistribution picture becomes more finely grained if we examine migration by subregions within the U. S. Table 2 provides net migration rates per 1000 population for the population aged 25 to 44 during the past 100 years. Of the four subregions showing net out-migration for 1970, only one, the Appalachian area, has net out-migration rates for both black and white populations. The West North Central subregion is experiencing a net in-migration of blacks and an out-migration of the white population. As noted above, the South as a whole has turned around its white out-migration since 1960, and the net out-migration rates shown for the subregions of Virginia, North Carolina, and the Deep South are a reflection of the continuing black out-migration.

This brief summary of the population redistribution of the last century has barely outlined some of the broad directions in migration. For the purposes of the present paper, though, this should be sufficient to give a general indication of some of the trends in migration and an idea of current directions. The Commission on Population Growth and the American Future has compiled an excellent set of research reports covering many aspects of demography, population problems and demographic planning. Volume five of the Commission reports, Population Distribution and Policy (1972b), provides a source of recent materials on population redistribution for those interested in a more detailed treatment.

Table 2. Net Decade Migration per 1,000 Population Aged 25 to 44 at End of Decade, Coterminous United States and Subregions, 1870-1970

	1870-1880	1880-1890	1890-1900	1900-1910	1910-1920	1920-1930	1930-1940	1940-1950	1950-1960	1960-1970
United States . .	59	91	61	92	46	41	0	11	19	39
New England	32	115	122	109	74	17	-2	-4	-13	48
Middle Atlantic	35	132	127	174	77	119	17	8	26	48
East North Central . . .	15	51	60	53	111	92	-2	32	46	33
West North Central . . .	225	162	-9	-7	-42	-86	-77	-110	-86	-43
Appalachian States . . .	-58	-67	-48	-81	-80	-87	-37	-128	-197	-81
Del., Md., D. C. . . .	27	45	52	41	116	15	167	171	81	135
Virginia, N. C. . . .	-50	-73	-84	-76	-44	-94	-24	-28	-82	-15
Deep South	-8	-16	-52	-39	-90	-150	-72	-162	-147	-69
Florida	91	218	130	236	127	331	209	255	423	194
Texas, Oklahoma	377	117	275	180	37	19	-64	-37	-14	19
Mountain	642	517	227	432	124	-42	12	52	132	69
Pacific	447	566	191	595	246	393	186	368	241	163

Source: Taeuber, 1972, p. 51.

Urbanization and Metropolization

In order to comprehend something about urbanization and the role of migration in this phenomenon, it is necessary to look first at some definitions and at some of the factors which have led to urban growth in the U. S. Obviously, the degree to which any country is "urbanized" will depend largely on the definitions used to characterize an urban place. In the case of the U. S., the definition of urban has related generally to the absolute size of the place under consideration. Places of less than 2500 population and unincorporated areas are considered rural; places of over 2500 population are considered urban. Under this definition, the United States has moved from a predominantly rural nation in 1900--with 60.3 percent of its population rural--to an overwhelmingly urban nation in 1970--with 73.5 percent of its population residing in urban areas (Taeuber, 1972).

While a portion of this urbanization process is attributable to the migration of rural residents to urban areas, migration is not the only component in the process. Indeed, a large part of the urbanization of America has taken place through the natural increase of the population. Areas which were once small in population have grown through natural increase to a point where they are more included under the definition of urban. The impact of natural increase, even in the rural areas, may be displayed graphically if we turn our attention away from percentage distributions for a moment and look at absolute numbers. In 1900 there were 45.8 million people living in rural areas. By 1970 the absolute number of persons living in rural areas had climbed to 73.5 million, while rural people had fallen drastically as a percentage of the total population. Inevitably, if this population increase continues, it will push more and more rural places beyond the 2500 population figure required to shift them to "urban" status. In fact Glenn Fuguitt, in a review of population trends in non-metropolitan cities (Fuguitt, 1972), has concluded that "the declining number and proportion of villages under 2500 in size is not due to their decline and disappearance, but basically due to growth" (p. 125). For the present discussion, the importance of findings like this is to underscore the fact that urbanization as a process does not mean only the massive movement of rural persons to urban places, but rather that migration is only one component in a complex demographic process.

In addition to the notion of urban places defined on the basis of population, the U. S. Bureau of the Census also recognizes metropolitan areas known in the census data as Standard Metropolitan Statistical Areas (or SMSAs). The idea of a special designation for large-scale urban areas with their adjacent dependent territories is quite old. The 1910 Census presented special data on some 25 cities of 200,000 or more population and their contiguous suburban areas. In one form or another, every census since that time has produced data on "Standard Metropolitan Statistical Areas" though there have been extensive definitional changes over time (Pickard, 1972). At present the general definition of an SMSA

is any city of 50,000 or more inhabitants (or pair of contiguous cities with combined populations of 50,000) together with its surrounding county and related contiguous counties under certain conditions. (See Shryock et al., 1973, p. 127, for a detailed explanation of the criteria for determining an SMSA.)

The growth and expansion of metropolitan areas have also contributed to the urbanization process. Whatever lands once existed around large cities have been progressively assimilated into the SMSA status as more and more Americans take up residence in the suburbs. Within the past 30 years the trend toward increasing metropolization has been strong.

The extensive use by Americans of personal forms of transportation, like the automobile, has opened up areas, even at great distances from cities, to habitation by extremely portable suburbanites.

The growth of metropolitan America during the 20th century displays two phases which might conveniently be labeled the urban phase and the suburban phase. During the urban phase of metropolitan growth, from 1900-1930, the percentage of the total population living in metropolitan areas grew from 41.9 percent to 54.3 percent, and the proportion of people living within the central city areas of the SMSA grew steadily. However, with the 1940 Census came the trend toward suburban living, and while the populations of SMSAs continued to grow, the heaviest growth concentration took place in the areas outside the central city. In fact, while the percentage of the total population of the U. S. living in SMSAs grew to 68.7 percent in 1970, the percentage of the population living in the central city has been declining slowly from a peak of 35.1 percent in 1930 to 31.4 percent in 1970. Obviously, then, the suburbs have absorbed the greatest part of metropolitan growth during the middle part of the 20th century.

Migration has been a significant factor in the urbanization of the U. S. The general population movement from the rural areas to the metropolitan areas can be noted easily in a survey of the patterns of migration between states of differing metropolitan characteristics. As of the 1970 Census it seems clear that there was a distinct relationship between the metropolitan status of a state and its net migration, with the least metropolitan states suffering the greatest out-migration, and the most metropolitan states receiving the highest rates of in-migration. Table 3 provides a graphic picture of this relationship.

The movement from less metropolitan to more metropolitan states has been even greater for black Americans than for the population as a whole. States with less than 15 percent metropolitan population experienced black net migration at the rate of -425 per 1,000 population during the 1960-1970 decade. The corresponding rate for states of greater than 85 percent metropolitan population was 394 per 1,000, a figure which leaves little doubt about the direction of black migration (Taeuber, 1972).

Table 3. Net Decade Migration per 1,000 Population Aged 25 to 44 by Metropolitan Status of States, 1960-1970

Percentage of Population in SMSAs	Migration/1,000 Population
Less than 15 percent	-134
15-24 percent	- 52
25-49 percent	- 48
50-74 percent	57
75-84 percent	65
85 and over	109

Source: Taeuber, 1972, p. 52.

Yet, whatever tendencies exist for migration toward metropolitan areas, it appears clear that cities themselves are not the areas of residential choice for most Americans. The trend toward suburbanization is now conditioning a dispersal of the American population. In particular, it is the more affluent white segment of the population who are leaving the central cities to settle in the less heavily populated suburban areas. Almost all of the SMSA central cities in the U. S. are currently experiencing a net out-migration of their white population, excepting some of the southern and western cities, and by and large it appears that the out-migration is being absorbed by the surrounding suburbs. In general it is also notable that the larger the SMSA, the greater the rate of out-migration is from the central city. For SMSAs over 2,000,000 population, the net migration rate for whites was -19.3. The vacuum left by these retreating whites is being filled rapidly by both the in-migration of non-whites and the natural increase of the urban population. Under the twofold influence of migration and natural increase, the SMSAs of the U. S. are experiencing growth and dispersion simultaneously.

POPULATION PROJECTION AND EDUCATIONAL PLANNING

For the educational planner, the end point of an interest in demography is likely to come down to a few simple questions--Where should I build a new school? How many students will need to be served in a particular area during the next ten years? Will the local school need more or fewer teachers, classrooms, or equipment during the next five years? To the extent that answers to questions like this can be found, they are likely to come through an awareness of the population to be served in any given area at any future point in time. Population projections provide the basis for estimates of the future populations of any area, and, depending on how the projections are carried out, they may provide, as well, information about the characteristics of those future populations. In general, a population projection is a statement about the size of a population in any given area at any future date based on a set of assumptions about the growth of the base population. Here we should distinguish at once between a population projection and a population forecast, since considerable confusion can arise between the two. A population projection is a conditional statement of fact. If the birth rate, the death rate, and the migration rate continue as assumed, the population of the U. S. in the year 2000 will be X. By changing the assumptions, different sets of projections may be obtained. Since projections are conditional statements based on assumptions, there may be no relationship to actual future populations. A forecast, on the other hand, is an actual prediction of a future population based on the most likely population projection. In essence, the forecaster selects that set of assumptions he believes most likely to hold true and makes his prediction based on those assumptions. In either case, what is most important in judging the utility of a projection or a forecast is a thorough understanding of the nature of the assumptions used to generate the final answer. Planners must take great care to avoid accepting projections as forecasts or presenting projections of their own as forecasts without adequate attention to the validity of the assumptions underlying the projections. For example, a ten-year projection of a county population based on the assumption that birth, death and migration rates will remain constant may be valueless if it can be shown that unfavorable local economic conditions are likely to have an adverse effect on migration.

While accurate population forecasts might seem the answer to the planner's prayers, it is much more likely that population projections will be more useful policy devices. A series of projections based on differing assumptions can provide planners with a set of future population figures which will allow for contingency planning. At the national level, the Bureau of the Census now provides series of projections for the U. S. population indicating a high projected population and a low projected population as well as mid-range projections which are hoped to more nearly approximate forecasts. The advantage of a series of

projections lies in the ability to evaluate any proposed policy in the light of several different alternatives. Additionally, since different projections will have different sets of assumptions, the development of a series of projections must involve analysis of a variety of assumptions about the future behavior of a population. Assumptions must be made explicit in any population projection or forecast if adequate policy use is to be made of these devices. This last point may be illustrated by noting that it can be more disastrous to make an accurate population projection for the wrong reasons than to make an incorrect forecast for the right reasons. For example, a ten-year population projection for a state might achieve 100 percent accuracy in terms of the total population projection by overstating births and deaths while understating migration. Continual planning for education on the basis of such a projection might result ultimately in planning for more children than will actually need to be considered. A continual monitoring of the data used for projections and the assumptions made in calculating the projection could prevent this situation.

Although there are varied methods available for making population projections, the interest of educational planners rests in those methods applicable to geographic subdivisions of counties and to small area projections. Because all of these methods must consider migration, they tend toward a much greater average error than do national projections. They also tend toward increased error with the length of the projection period. In fact, "after 20 years no method any longer provided accurate forecasts" (Shryock et al., 1973, p. 806). These facts serve to underscore the need for continual re-examination and monitoring of small area projections in order to ensure their maximum utility.

General Methods of Projection

While it is not the purpose of this report to provide a guide for making projections, it is worthwhile to conclude here with a brief examination of some of the methods used in making projections. The simplest techniques for population projection are extrapolation techniques, in which the extrapolation may be done either mathematically or graphically. In its most rudimentary form, the extrapolation takes the form of a straight line on a graph or a first degree polynomial as a mathematical function. What little advantage accrues to this method of projection lies in its simplicity. For the local planner who may not be trained in demography, it is relatively easy to obtain census data for the local population from years past and simply extrapolate that data to whatever future time is desired. A certain degree of sophistication in extrapolation techniques may be achieved by applying various curves instead of making straight line extrapolations. Polynomial curves, exponential curves and logistic curves have been used for this purpose with varying degrees of success. From the point of view of the planner, this type of projection has two basic weaknesses. First, any extrapolation technique must ultimately rest on the assumption that future growth

is a function of past relationships. Second, and more critical to the planner, extrapolation techniques as applied to the growth of whole populations do not provide the analytic detail necessary for planning. Even if extrapolation did provide an accurate projection of future population, it would yield no data on the age structure or general characteristics of that population.

Another relatively simple type of population projection is the ratio method. In this method, the growth of one subdivision is compared to some larger unit of which it is a part and for which a projection has already been made. For example, if projections have already been made for the population of a state from 1970 to 1980, projections of the populations of counties within the state might be made using the ratio method. A ratio projection in this case would simply take one or more observations of the past relationship between county population and state population and apply the chosen ratio to the state projection to obtain the county projection. A certain amount of sophistication may be achieved with this method if the chosen ratio takes into account observable trends in past relationships--i.e., if historical observation indicates the county is growing proportionately more rapidly than the state, a slightly higher ratio would be chosen.

One advantage of the ratio projection method over the extrapolation procedure is that it may readily be adapted to make projections of distributions by age, sex, race, or various socioeconomic characteristics. While these procedures are somewhat more involved, they are not difficult. (Interested readers may find a description of the procedure in Shryock et al., 1973, pp. 794-795.)

As a relatively simple procedure, requiring little sophistication and only limited data, the ratio method of projection, if carried out by at least age distributions, would seem to hold some promise for the local planner. Neither the initial calculations nor monitoring and updating would appear to be taxing of local resources, providing that adequate state projections can be made available. What should be made explicit in the projections are the assumptions underlying the selection of ratios used in comparing the state and local data. A significant weakness in the method lies in the fact that migration is the factor most likely to have an effect on the changing relationship between the smaller population and the parent population. Other than continual monitoring and updating of projections, there is no way to account for differences brought about by migration.

A more sophisticated technique is the cohort-component method which may be applied with varying degrees of refinement. Depending upon the data and the sophistication of the user, this method can provide for consideration of several components of population change, including birth rates, death rates, net migration, gross in-migration and gross out-migration (Shryock et al., 1973, p. 796). A particular advantage to the method is that it provides age and sex distributions as well as aggregate

totals. There are also advantages from a planning standpoint. Since the cohort-component method deals explicitly with the components of change in the population, assumptions about the nature and direction of change are explicit and available for review. The disadvantages of the method are largely due to the data requirements and the degree of sophistication required to complete a projection. It appears likely that the method will find much more application at the state than the local level.

Finally, the increasing use of the computer in demographic work has led to the use of modeling procedures in population projections. Mathematical models of population have been used in the recent past to make projections of the U. S. population to 1980 (Balestra and Koteswara Roo, 1964). Using regression analysis, this model relates net migration to average per capita income in order to provide the projections. Other models have used such economic characteristics as employment levels or production.

Simulation modeling has also been attempted both in modeling the activities of populations and in making projections. Models have been developed for reproduction (Potter and Sakoda, 1966), migration (Rogers, 1966), and even a total demographic model which generates an initial population, induces vital events over time, and tabulates the resulting population by age, sex, marital status, and other characteristics (Horvitz et al., 1969).

From a planning standpoint, most of those models are likely to be viewed, at least for the present, as research tools rather than as instruments for planning. Even the simplest of the mathematical modeling procedures requires both detailed data and considerable user sophistication. Additionally, all of the research is not yet complete on the relationships between demographic events and other indicators. However, in the relatively near future demographic modeling could become an important factor in educational planning. As more models are built and tested, the likelihood is increased that canned programs will be made available to planners which could require little more than the collection and input of standardized data in order to achieve sophisticated long-range projections. With the growing amount of research in this area and the increasing accessibility of computers, this should be viewed simply as a matter of time. Although for the near future we hold little hope for greatly increased accuracy in projections, greater sophistication at relatively low cost would be a step forward.

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